

MONTHLY WEATHER REVIEW,

MARCH, 1877.

WAR DEPARTMENT,

Office of the Chief Signal Officer,

DIVISION OF

TELEGRAMS AND REPORTS FOR THE BENEFIT OF COMMERCE AND AGRICULTURE.

INTRODUCTION.

The present Review for the month of March depends upon all data received from United States and Canadian stations up to the 14th of April. The most noticeable features recorded during March are: the very severe storm No. X and its unusually slow movement along the Atlantic coast; the heavy rains and snows of the Ohio valley, Lower Lakes and Atlantic States; the freshets in the rivers of the Middle and Eastern States; the aurora of the 9th.

BAROMETRIC PRESSURE.

In General.—The general distribution of atmospheric pressure is shown by the isobars upon chart No. II, from which we see that the area of mean highest pressure extends from Florida and South Carolina westward to Texas and Kansas. The lowest mean pressure is at the mouth of the St. Lawrence. This distribution agrees with that of March, 1874, but is the reverse of that of March, 1875-'76. The temperatures during the subsequent April of those years were, in 1874, much below the average, and in 1875 somewhat below, but April, 1876, was colder east of the Alleghanies and warmer to the westward.

Barometric Range.—The greatest barometric ranges have been as follows: 1.51 inches at Malone; 1.49 at Baltimore; 1.48 at Oswego; 1.46 at Philadelphia and Washington. The least ranges have been: San Diego, 0.35; Key West, 0.43; San Francisco, 0.53; Punta Rassa, 0.57; 0.64 at Cheyenne and Indiana; 0.65 at Galveston; 0.73 at Pike's Peak; 0.75 at Salt Lake City. The general range of the barometer for the whole country is best seen by the following table, which gives the maximum and minimum readings at the centres of the respective areas of high and low pressures:

AREA. No.	MAXIMUM BARO- METER IN HIGH AREAS.	MINIMUM BARO- METER IN LOW AREAS.	AREA. No.	MAXIMUM BARO- METER IN HIGH AREAS.	MINIMUM BARO- METER IN LOW AREAS.
I.	30.34	29.07	VII.	30.39	29.35
II.	30.28	29.52	VIII.	30.50	29.75
III.	30.15	29.50	IX.	30.37	29.54
IV.	30.45	29.00	X.	30.14	29.02
V.	30.61	29.76	XI.	30.64	29.62
VI.	30.48	29.15	XII.	30.46	29.20

Areas of High Pressure.—The areas of high barometer have not been remarkable either for geographical extent or high central pressure. A very considerable amount of cold air has existed north of our stations, and to its somewhat unusual extent southward seems to be attributable the large number of storms that have pursued their courses eastward over the Ohio valley.

In detail, the areas of high pressure were as follows:

No. I.—Central on the 1st at 7:35 a. m. in Virginia and continued stretching along the Atlantic coast during the 2nd.

No. II.—Represents an accumulation of air along the East Atlantic coast due to the in-draught from the eastward, attending low barometer No. I, which was then over the Lake region.

No. III.—Originated in the southerly winds drawn northward over the Southern States on the 2nd and 3rd, while low barometer No. II was developing in Missouri.

No. IV.—Is the high barometer that followed low No. II. It extended from the Pacific coast eastward over the greater portion of the Southwest, and was central in Arkansas at 7:35 a. m. of the 5th. Its boundary continued extending eastward while the central highest pressures were, at 7:35 a. m. of the 5th,

still in the Missouri valley; by this time also pressures had begun to fall, with rain, in Oregon. By 7:35 a. m. of the 6th low barometer No. III had become developed to the northward, and high No. IV was central over Louisiana and Tennessee. During the next twenty-four hours it advanced to the South Atlantic coast and there remained.

No. V.—Extended on the 7th at 7:35 a. m. eastward along the northern border of the Lake region and the Northwest. Its eastern portion subsequently passed southeastward over New England and the Canadian Provinces. Its western portion continued over Manitoba and the Northwest, gradually extending southward until, at 7:35 a. m. of the 9th, the highest pressure was over Nebraska and northern Texas. During this interval low barometer No. IV had acquired its remarkable extension. The area of highest pressure now advanced eastward, and was on the 10th, at 7:35 a. m., over Tennessee, and on the 11th, at 7:35 a. m., over Virginia. The pressure remained high throughout the Atlantic States during the 11th, while low barometer No. V was developing west of the Mississippi.

No. VI.—Appears on the 13th, at 7:35 a. m., between the low barometers Nos. V and VI as a ridge of high pressure extending from the Southwest to the mouth of the St. Lawrence. The northern portion of this area moved eastward over the Gulf of St. Lawrence. The southern portion continued in the West Gulf States, being central, at 7:35 a. m. of the 14th, in Louisiana, after which it became merged into high No. VII.

No. VII.—Had its origin in the in-draught of cold air from the Northwest, following low No. VI. It was central at 7:35 a. m. of the 14th, in Dakota, whence it rapidly moved down the Missouri valley and was, at 7:35 a. m. of the 15th, central near Cairo, and by 7:35 a. m. of the 16th had spread over the South Atlantic States.

VIII.—Followed in the rear of low barometer No. VII, and was, at 7:35 a. m. of the 16th, central in Manitoba, but at 7:35 a. m. of the 17th, central as a ridge extending from Lake Huron to Kansas. During the next twenty-four hours this ridge assumed larger proportions, and at 7:35 a. m. of the 18th covered the Gulf States and St. Lawrence valley, the pressure being highest at the southwestern extremity. During the next twenty-four hours its southern portion extended eastward over the Atlantic States and remained until the 19th.

No. IX.—Appears first, at 11 p. m. of the 19th, central over the Lake region, whence it moved south-eastward to the Middle Atlantic coast.

No. X.—Had its origin in the northerly winds that prevailed, on the 20th, west of the Mississippi in the rear of low No. IX. It was central at 7:35 a. m. of the 21st, in Indian Territory and moved thence eastward until, at 7:35 a. m. of the 22nd, it extended as a ridge from Louisiana to West Virginia, separating low barometers No. X and XI. After this the highest pressure diminished, while the isobars retreated southward and, at 7:35 a. m. of the 23rd, only a comparatively slight elevation was central in the Eastern Gulf States.

No. XI.—While the barometric trough No. X was on the 23rd over the Ohio valley and the Southwest, the pressure rapidly increased to the northward, with cold northeast winds; and on the 24th, at 7:35 a. m., the area of highest pressure extended over Dakota and Lake Superior. The barometer, during the rest of the day, rose very rapidly at the Canadian stations, and especially over the Gulf of St. Lawrence, but fell west of the Upper Mississippi, so that, at 7:35 a. m. of the 25th, the highest pressure was north of New Brunswick, and at 7:35 a. m. of the 26th, east of Cape Breton, where it continued high until the morning of the 27th, preceding low barometer No. X.

No. XII.—This area of high pressure originated in the northerly winds following low barometer No. X. It was apparently central in Manitoba at 7:35 a. m. of the 27th, whence it extended rapidly southward and slowly eastward. At 7:35 a. m. of 29th, was central over Lake Superior; at 7:35 a. m. of 30th, over Lake Huron, and at 7:35 a. m. of 31st, off the Middle Atlantic coast.

Areas of Low Pressure—In general.—These have, during March, presented several interesting features. Of the twelve tracks charted on map No. I, one, No. XI, lies entirely to the east of the Atlantic coast; two Nos. III and VI, lie on the northern border of our stations; of the remaining nine, some were preceded by depressions on the Pacific coast; but, in general, they may be said to have begun on the east slope of the Rocky Mountains, and after extending slowly southward into Kansas, or even into Texas, moved northeastward generally over Missouri and Indiana to the Gulf of St. Lawrence.

Areas of Low Pressure—In detail.—No. I was central in eastern Texas on the morning of the 1st, while a very general depression extended thence northward into British America, with southeast winds and cloudy followed by rainy weather. During the day the area of cloud and rain extended eastward to the Atlantic and northward over the Lake region, while the barometer fell rapidly from the South Atlantic and Middle States westward to the Pacific. The central lowest pressures were on the 1st, 7:35 a. m., 28.70 in., at 4:35 p. m., 29.55, 11 p. m., 29.40; on the 2nd, 7:35 a. m., 29.10, 4:35 p. m., 29.05, on which latter

date the centre was near Lake Huron, after which it passed more nearly eastward to the Gulf of St. Lawrence, over which it appears to have been central on the afternoon of the 3rd.

No. II.—The cold northerly winds that prevailed from Dakota to Texas during the 2nd, were followed by rapidly falling barometer in Kansas where winds shifted to southerly, and at 7:35 a. m. of the 3rd the lowest pressure was central near the southeast corner of that State. During the remainder of this day the principal rain and snow-fall took place over the Lake region, Middle and Eastern States, whence it extended southwestward into the Ohio valley. The lowest pressure was, at 4:35 p. m., central in Indiana, and at 11 p. m. in northern Ohio, but at 7:35 a. m., of the 4th, extended from New York northward over the St. Lawrence valley, and at 4:35 p. m. was near the mouth of that river. This depression seems to have remained over the Gulf of St. Lawrence until the afternoon of the 5th.

No. III.—The barometer fell steadily during the 5th in Manitoba and Oregon, while high barometer No. II was moving southeastward toward the Southern States. The lowest pressure passed over Fort Garry, Pembina and Breckenridge after the 5th, 11 p. m., and was on the 6th, 7:35 a. m. central near Duluth. The depression extended southward and eastward until at 4:35 p. m., it had assumed a trough-like shape, whose axis stretched from northern Texas over Mackinac into Canada, while rapidly rising barometer and cold northerly winds prevailed to the westward. These latter winds subsequently divided the trough into two portions, the southwestern one of which is described as storm No. IV. The northern division, or low barometer No. III, moved eastward over Canada, reaching the St. Lawrence valley at 7:35 a. m. of 7th, at which time light snows were reported from a few stations in northern New York and New England, and after this it disappeared over the Gulf of St. Lawrence.

No. IV.—This storm, which originated at the southwestern end of the trough mentioned in the preceding section, was on the 6th, at 4:35 p. m., central in Indian Ty., where cold northerly winds were at that time beginning to encounter the warm southerly winds of the Western Gulf States. The area of cloud and rain very rapidly extended northward, being at 11 p. m. of the 6th, on the southern coast of Texas, but at 7:35 a. m. of 7th covering the whole country west of Lake Superior, Ohio and Mississippi. By 11 p. m. of 7th, the lowest pressure had moved northeastward into Missouri, while rain and snow prevailed over the Lake region, Northwest and Southwest. At 7:35 a. m. of 8th, the lowest isobar, 29.50, constituted an ellipse whose longest axis stretched from Arkansas to Indiana, measuring about five hundred miles, and shortest about one hundred miles. During the rest of the 8th, the pressure fell throughout the Northwest, Lake region and Atlantic States, but rose at the Southwest and Rocky Mountain stations, and the lowest barometer moved into central Ohio where, at 4:35 p. m. of 8th, the lowest pressure was 29.15 in., as compared with 29.45 at the centre in the morning. High winds were now very generally reported from the Atlantic coast, and a "norther" prevailed in the Western Gulf. At 11 p. m. of 8th, the lowest pressure was 29.05 in., central on the boundary between Pennsylvania and Ohio, and at 7:35 a. m. of 9th, the central pressure was less than 29.00 in. in Northern New York, with southerly gales along the Atlantic coast, and high westerly winds over the Lower Lakes. During Friday, the storm-centre continued its slow progress eastward, and was, at 7:35 a. m. of 10th, apparently over the Gulf of St. Lawrence.

No. V.—While high barometer No. V was extending southward over the Gulf States, in the rear of low pressure No. IV, a very general depression seems to have moved southeastward on the 9th over the Pacific coast and Rocky Mountain stations. The pressure was lowest in Oregon at 4:35 p. m., 10th, with rain, while slight depressions were also then central west of Missouri and north of Lake Superior. The latter region was at once covered by an extensive area of northerly winds, high pressure and cold weather, so that at 4:35 p. m., of the 11th, the western depression only remained, being then central in Kansas, where the barometer had fallen three-tenths of an inch in twenty-four hours. This depression, like its predecessor, developed as a very elongated ellipse, trending northeastward and southwestward, and moving slowly eastward over the Ohio valley to western Pennsylvania, where it was central at 11 p. m. of the 12th, whence, however, it passed eastward over the Alleghenies and was, at 7:35 a. m. of the 13th, central off the New Jersey coast. After this its path can no longer be followed on our maps, but was probably northeastward, bringing it near Cape Breton at 7:35 a. m. of the 14th.

No. VI.—While the preceding storm was, on the 12th, in the Ohio valley, the barometer fell quite low (29.71) at Portland, Or., with southerly winds and rain, and also began to fall rapidly in Manitoba, with southeast winds and rain or snow. At 7:35 a. m. of 13th, the central lowest pressure apparently extended from eastern Dakota northward into British America. It was, at 4:35 p. m., near Lake Superior, with brisk and high northwest winds to the westward. After moving southeastward to Lake Huron the depression turned northeast down the St. Lawrence valley, and at 7:35 a. m., of 15th, extended from Maine northward beyond our stations. At no time, thus far, had any but the southern edge of this depression been presented upon our weather maps, and it is likely that the storm-centre proper was somewhat to the north of the track given upon chart No. I, but at 4:35 p. m., of 15th, the southern end of the depression had developed into a separate storm-centre, central southeast of Maine, with very rapidly falling barometer. This depression passed over the Gulf of St. Lawrence during Thursday night and was, at 7:35 a. m., of 16th, apparently central near southern Newfoundland.

No. VII.—The area of high barometer No. VII, central on the morning of the 15th, near Cairo was at that time already being followed by a decided barometric fall at the Rocky Mountain stations, from Montana to Texas, while the pressure continued high from Illinois to Wisconsin and eastward. During the rest of the 15th, currents of air seem to have set in from all directions toward Kansas, in the western portion of which State the central lowest pressure was developed. The storm-centre moved thence southeastward to southern Missouri, and thence eastward into Kentucky, where it was central at 4:35 p. m. of 16th, at which time the isobar of 29.70 extended from Texas northeastward to West Virginia, and a very extensive area of high pressure and cold northerly winds prevailed thence northward into the British Possessions. A belt of very steep temperature gradients extended from northern Texas to West Virginia, coinciding with the trough of barometric depression. These conditions moved slowly eastward to the opposite side of the Alleghanies during Friday night, while the central barometric pressure rapidly rose and was located in North Carolina at 7:35 a. m. of 17th; here the depression delayed, while the area of snow and rain extended both northward and southward, after which, it advanced more rapidly northeastward to Nova Scotia, keeping always near the coast. This northeastward advance may, perhaps, be properly spoken of as the progressive closing up on its southern side of the barometric trough that, on the morning of the 17th, extended from Florida to Nova Scotia. In the course of its progress northeastward, the central depression gradually assumed a nearly circular form, and was, at 4:35 p. m. of 18th, in Nova Scotia, with a minimum barometer 29.55. After this, the pressure rapidly diminished, being at 11 p. m., 29.35, and at 7:35 a. m. of 19th, probably as low as 29.20 over the central portions of the Gulf of St. Lawrence.

No. VIII.—During the 17th the general trend of the isobars over the whole country east of the Rocky Mountains was northeastward and southwestward, and at 11 p. m. a ridge of high pressure, extending from Texas to the mouth of the St. Lawrence, separated depression No. VII on the Atlantic coast from the slight depression that extended through Michigan, Indiana, Missouri and Kansas, while a second area of high barometer appears in Minnesota and Manitoba. This latter extended eastward, but the barometer fell decidedly from Utah to Manitoba, and southward to Texas and Tennessee. Up to 4:35 p. m. of the 18th, this depression seems to have extended irregularly from Indian Territory northwestward to Dakota, but at 11 p. m. was evidently central in Kansas, whence it moved rapidly eastward, and was, at 7:35 a. m. of 19th, in Illinois and Indiana, at 4:35 p. m. in West Virginia, and at 11 p. m. east of the Middle Atlantic coast.

No. IX.—The very rapid eastward progress of No. VIII, on the 19th, was not followed by any decided recovery of pressure west of the Mississippi, but during the greater part of the day the pressure remained low in that region, and a belt of low pressure connected it with No. VIII. At 7:35 a. m. of 20th, the area of falling barometer extended from Texas northward to Iowa and the Upper Lakes, while rapidly rising barometer and cold northwest winds prevailed from Colorado and Utah to Manitoba; the central depression No. IX is placed in central Kansas at 7:35 a. m. of the 20th, and at 4:35 p. m. in eastern Illinois, at which time the centre of the State was crossed, from east to west, by a belt of very great temperature contrasts, followed about 6 p. m. by a series of local storms of the nature of small whirlwinds. At 11 p. m. the storm-centre was in southeastern Indiana, and at 7:35 a. m., of 21st, in western Pennsylvania, at 4:35 p. m. in the St. Lawrence valley, and at 11 p. m. had moved northeastward beyond our stations.

No. X.—The very low barometer in Oregon, at 11 p. m. of the 20th, was followed by a decided fall during the 21st west of the Lower Mississippi and Lower Missouri valleys, and at 4:35 p. m. a depression extended from Nebraska to Lake Superior and beyond, of which the western end developed into storm No. X. It was, at 7:35 a. m. of 22nd, central in Iowa, and, at 4:35 p. m., in Missouri. The central lowest pressure had, in the preceding twenty-four hours, fallen twenty-hundredths, and now extended as a very long oval from southern Kansas to northern Illinois, while the isobars west of the Alleghanies trended northeastward and southwestward even more decidedly than they had on the afternoon of the 16th. (See No. VII.) At 11 p. m. of 22nd the lowest isobar, 29.70, constituted a remarkably long, sinuous trough, extending from Lake Huron to Indian Territory, a distance of eight hundred miles, with an average width of less than one hundred. This trough separated the two regions (Nos. X and XI) of high pressure, with corresponding warm southerly and cold northerly winds that were then central, respectively, over the East Gulf States and Manitoba. At 7:35 a. m. of 23rd these areas of high pressure had encroached upon the northeast end of the depression, and the barometer had so generally risen that the isobar of 29.80 covered scarcely one-fifth of its area at the previous report, and was confined principally to northern Texas, Indian Territory and Arkansas; meanwhile depression No. XI was advancing northward and rapidly developing off the Atlantic coast, and, at 4:35 p. m. of the 23rd, the map presents three depressions, central, respectively, in northeastern Texas, West Virginia and Nova Scotia, all which doubtless formed but a part of a trough, extending further than from northern Mexico to Cape Breton. This depression was followed, as usual, by a speedy inflow of air from both the north and south, so that the 11 p. m. map, and still more, that of 7:35 a. m. of 24th, shows areas of rising and high barometer over the Upper Lakes, Northwest and Southwest, and also over the South Atlantic States. The region of cloud and rain or snow at the latter date covered the Gulf States, Ohio valley, and a large portion of the Lake region, Middle and Eastern States. The area of low pressure

No. X continued west of the Mississippi, and moved southward, keeping company with the advance of the southernmost point of the area of cold northerly winds until the latter reached the Gulf of Mexico, after 11 p. m. of the 23rd. In general, the barometric troughs mark the region in which an area of cold air is meeting and under-running warmer air, and, accordingly, the eastward movement of low pressure No. X, during the rest of Friday night and early Saturday morning, marks the advance eastward along the west Gulf coast of the "severe norther" that began at Indianola at 12:35 a. m., Galveston 7:10 a. m., and New Orleans in the evening. By 11 p. m. of the 24th the lowest pressure, 29.80, had moved slightly northward into western Alabama, and the area of warm southerly winds was confined to the South Atlantic and East Gulf States, while cold northeast winds and steadily rising barometer extended from the Middle States and Lower Lakes northward over the St. Lawrence valley, where the pressure was then highest. By 4:35 p. m. of the 25th the central depression had diminished twenty-hundredths, and the attending winds and rains decidedly increased. The oval isobars had become more circular, and were central in eastern Georgia. From this time on the progress of the storm-centre, which had already been unusually slow, becomes the slowest of which we have any record over so long a period. It passed from Georgia steadily northeastward to the Gulf of St. Lawrence, occupying six days in its passage. The central lowest pressures were, 25th, 4:35 p. m., 29.55, in northeastern Georgia; 26th, 4:35 p. m., 29.30, in southeastern Virginia; 27th, 7:35 a. m., 29.30, in eastern New Jersey; 27th, 4:35 p. m., 29.20, east of New Jersey; 28th, 4:35 p. m., 29.05, southeastern Massachusetts; 29th, 4:35 p. m., 29.35, New Brunswick; 30th, 4:35 p. m., near Newfoundland; 31st, 4:35 p. m., east of Newfoundland. The brig George, from Maunabo, was in the centre of the storm from 8 a. m. of the 27th to after 4 p. m. of the 28th, while waiting to round Montauk Point. The brig Maggie Glen encountered the storm-centre on the 26th and 27th.

No. XI.—The maps of the 21st show that a depression was during that day east of Florida, moving northward toward the South Atlantic coast. During the 22nd the depression evidently passed northeastward very near Cape Hatteras. At 7:35 a. m., of 23rd, was off Cape Cod, at 4:35 p. m. was central in Nova Scotia, and by 11 p. m. had passed eastward beyond our stations. The brig George, from Maunabo to New London, encountered this storm on the 22nd when off the Carolina coast.

No. XII.—While low barometer No. X was, on the 24th, central in the Lower Mississippi valley, and high barometer No. XI was extending eastward, north of the Lake region, the pressure fell slightly at the Rocky Mountain stations and in Manitoba, and, on the afternoon of the 25th, the southern end of the depression extended southward over Minnesota. By the afternoon of the 26th the barometer had risen over the Upper Lakes, but had fallen in Nebraska and the Southwest. At 11 p. m. the depression was central in Kansas. At 7:35 a. m., 27th, it had moved southward into Indian Territory, while the barometer had risen rapidly to the northward. The central depression continued at the extreme southwestern limit of our stations until the afternoon of the 29th, by which time high barometer No. XII had moved southeastward to the Lakes, while the pressure had also been diminishing at all the Pacific coast and Rocky Mountain stations. Consequently, at 4:35 p. m. of the 29th, the isobar of 30.00 stretched from Manitoba southward over Texas, with a large region of low barometer to the westward, the greatest depression being probably in Wyoming or Idaho. During the next twenty-four hours pressure continued slowly falling between the Mississippi and Rocky Mountains, but rose on the Pacific coast, and at 4:35 p. m. of the 30th, the central depression was probably in southern Dakota; at 11 p. m. it had moved southward to Nebraska, but at 4:35 p. m., of 31st, was in the southeastern corner of Dakota, and at 11 p. m. in southern Minnesota. At this latter date the area of threatening and rainy weather covered the Middle States, Gulf States, Northwest and Lake region. The further history of the storm belongs to April.

Vessels Experiencing Storms.—Reports of storms at sea have been gathered from miscellaneous sources as follows: 1st, 35° 20' N., 63° 45' W., hurricane; from lat. 43° to 45° N., and long. 44° to 56° W., strong N. and W. gales. 2nd, from 34° N. to 45° N., off the Middle Atlantic coast, severe NE. to SE. gales. 9th, off the Middle Atlantic coast, SE. to SW. winds of hurricane force. 22nd, in 34° N. 74° W., a SE. gale, lasting 26 hours. 25th, 49° 32' N., 22° 23' W., strong gale and high sea. 27th, 32° 17' N., 78° 12' W., heavy NW. gale. 30th, off Cape Hatteras, heavy N. gale, lasting 34 hours.

TEMPERATURE OF THE AIR.

The general distribution of temperature for the month is shown by the isotherms upon chart No. II. As the temperatures here given depend entirely upon the observations made at the regular Signal Service and Canadian stations, they have, in the small table upon the same chart, been compared with the observations made at the same stations since their establishment in 1870 or subsequently. This comparison shows that the present month has been slightly warmer than during recent years throughout the Atlantic States and also on the Pacific coast, but has been slightly colder in the St. Lawrence valley, the Lake region, Ohio valley and Northwest. Reports from Newfoundland show the month to have been unusually warm in that region. The isotherm of 60° passes from southern Georgia along the East Gulf coast through southern Louisiana into Texas. The isotherm of 20° passes from the mouth of the St. Lawrence southwest to Lake Huron and thence west-